REMARKS

Claims 1 and 3-17 are pending in the Application prior to the amendments herein.

Claims 1 and 3-17 are rejected.

Claim 3 is cancelled herein.

Claims 4, 12, and 17 are amended herein.

Claims 1 and 4-17 are pending after entry of the amendments herein.

1. Rejections Under 35 U.S.C. §103(a) over Smalley in view of Kawamura

The Examiner has rejected Claims 1, 5, 12 and 17 under 35 U.S.C. § 103(a) as being unpatentable over Smalley et al., U.S. Patent 6,683,783 B1 ("*Smalley*") in view of Kawamura et al., U.S. Patent 6,706,431 B2 ("*Kawamura*"). Final Office Action at page 2.

Applicant respectfully traverses the rejection.

Applicant has amended Claim 1 to include the element of Claim 3: the fuel cell electrode comprises single-wall carbon nanotubes that are derivatized with a functional group. Applicant has also amended claim 1 to state that the single-wall carbon nanotubes have a diameter of about 0.7 – 3.5 nm. This is supported in the specification at page 11, lines 7-8.

In the Final Office Action at page 3, the Examiner states "Smalley et al. doesn't explicitly teach the use of the SWNT to form a fuel cell electrode." Furthermore, although *Kawamura* mentions carbon nanotubes as part of a hydrogen absorbable material in a fuel cell (column 3, lines 42-48), it does not suggest a fuel cell electrode comprising single-wall carbon nanotubes or a fuel cell electrode comprising single-wall carbon nanotubes that are derivatized with a functional group, as required by Claim 1.

Claim 3 is hereby cancelled. Claims 5, 12 and 17 are dependent upon amended Claim 1 and are not *prima facie* obvious for the same reasons that amended Claim 1 is not *prima facie* obvious.

The Examiner stated that Claims 12 and 17 merely recite statements of intended use which were given no patentable weight. Applicant respectfully points out that this is not correct. Claim 12 stated that the electrode is a component in a hydrogen/oxygen proton exchange membrane fuel cell (PEMFC), and Claim 17 stated that the electrode is a component in a direct methanol fuel cell (DMFC). Both of these are specific structural limitations, specifically, that the electrode is part of a larger apparatus which is explicitly recited in the claims. These cannot be construed as mere statements of intended use (e.g., "The electrode of claim 1, for use in [other apparatus]"). Therefore, the limitations of Claims 12 and 17 cannot be ignored when assessing patentability.

However, to expedite prosecution of this application, applicant has amended Claims 12 and 17 to make the structural nature of these limitations even clearer. Claim 12 now recites a hydrogen/oxygen proton exchange membrane fuel cell that comprises the electrode of Claim 1. Claim 17 now recites a direct methanol fuel cell that comprises the electrode of Claim 1. After these amendments, there is clearly no basis for ignoring the language of these claims.

In light of the foregoing, Applicant respectfully requests that the Examiner withdraw the rejection of Claims 1, 5, 12 and 17 under 35 U.S.C. § 103(a) as obvious over *Smalley* in view of *Kawamura*.

2. Rejections Under 35 U.S.C. §103(a) over Smalley in view of Kawamura and further in view of Fisher

The Examiner has rejected Claims 3 and 4 under 35 U.S.C. § 103(a) as being unpatentable over *Smalley* in view of *Kawamura* as applied to Claim 1 above, and further in view of Fisher et al., U.S. Patent 6,203,814 ("*Fisher*"). Final Office Action at page 3.

Applicant respectfully traverses the rejection.

Claim 3 has been cancelled herein, and therefore the rejection of this claim is now moot.

Claim 4 has been amended to be dependent upon Claim 1, which has been amended, as stated above, to claim a fuel cell electrode comprising single-wall carbon nanotubes that are derivatized with a functional group.

The Examiner contends that "Fisher discloses a method of making functionalized nanotubes." Final Office Action, at 4. However, the nanotubes of *Fisher* are not single-wall carbon nanotubes, but rather fibrils. *Fisher* teaches functionalized fibrils, which are also referred to as buckytubes, graphitic nanotubes, tubular fullerenes and nanofibers. (See *Fisher* at Col. 1, *ll.* 5-7 and *ll.* 52-53.) Fibrils are also quite different than single-wall carbon nanotubes.

Note also that Fisher refers to the "surface carbons of a substantially cylindrical graphitic nanotube of substantially constant diameter." (Column 4, lines 42-44.) The reference to "surface" carbons makes it clear that single-wall nanotubes are not involved.

The distinction between single-wall carbon nanotubes and fibrils is important because fibrils are fundamentally different from single-wall carbon nanotubes. The structural differences between single wall carbon nanotubes and fibrils cause the materials to have very different properties, as well as significant and unpredictable chemical reactivity and performance differences. Whereas the single-wall carbon nanotubes of Claim 1 have diameters from about 0.7 nm to about 3.5 nm, fibrils are much thicker. Whereas single-wall carbon nanotubes are

highly flexible, fibrils are quite stiff, rigid and inflexible. Because single-wall carbon nanotubes have only a single layer of generally defect-free sp^2-hybridized carbon atoms, they generally cannot support defects in growth and are more susceptible to destruction by bond breakage or reaction. Fibrils, in contrast, are composed of many, generally cylindrical, concentric carbon layers. Because of this arrangement, the carbon shells of fibrils can withstand wall defects, which often appear as dislocations, kinks, holes, edges on the side-wall surfaces, *etc*. Whereas single-wall carbon nanotubes "rope" and are held tightly together by van der Waals forces, making them difficult to separate and disperse in other media, fibrils, in contrast, do not "rope" together and are readily separable and dispersible. Also, because of their multiple layers and the interconnections between these layers, fibrils can withstand much more rigorous chemical processing (such as those incurred during functionalization and derivatization), physical conditions, and extensive chemical bond breakage without nanotube destruction which can often, and more easily, occur with single-wall carbon nanotubes.

The many structural differences between single-wall nanotubes and fibrils also result in numerous differences in physical and chemical properties, such as tensile strength, modulus, flexibility, thermal conductivity, electrical conductivity, chemical reactivity and chemical stability. In turn, the multitude of physical and chemical fundamental differences between single-wall nanotubes and fibrils provide a basis for expecting and obtaining quite different results in compositions or structures comprising them.

In light of the foregoing, Applicant respectfully requests that the Examiner withdraw the rejection of Claim 4 under 35 U.S.C. § 103(a) as being unpatentable over *Smalley* in view of *Kawamura* and further in view of *Fisher*.

3. Rejections Under 35 U.S.C. §103(a) over Smalley in view of Kawamura

The Examiner has rejected Claim 6 under 35 U.S.C. § 103(a) as being unpatentable over *Smalley* in view of *Kawamura* as applied to Claim 1 above, and further in view of Satoru et al., JP 08-031444 ("*Satoru*"). Final Office Action at page 4.

Applicant respectfully traverses the rejection.

Claim 6 is dependent upon Claim 1, which has been amended, as stated above, to claim a fuel cell electrode comprising single-wall carbon nanotubes that are derivatized with a functional group. Claim 6 further requires that the catalyst metal comprises platinum and ruthenium. *Smalley* does not suggest an electrode for a fuel cell that comprises a combination of platinum and ruthenium. *Kawamura* does not suggest single-wall carbon nanotubes, or single-wall carbon nanotubes that are derivatized with a functional group and have a diameter of about 0.7 – 3.5 nm.

Satoru teaches buckyballs, C_{60}, and fullerenes, such as C_{70} and C_{120}, as carbon supports for a metal catalyst. *Satoru* teaches platinum as a catalyst metal. *Satoru* discusses metals that are effective in the dissociative adsorption of hydrogen:

> Moreover, as the metal catalyst which acts effective in the dissociative adsorption of hydrogen, use of many metals, such as palladium and nickel, is also possible besides the platinum stated in the example.
>
> (*Satoru* at paragraph 35.)

Thus, *Satoru* teaches other catalyst metals that are not necessarily noble metals, such as nickel. However, *Satoru* does not teach any combination of metals as the catalyst. *Satoru* does not suggest the use of single-wall carbon nanotubes with the catalyst, or for the catalyst metal to comprise a combination of platinum and ruthenium.

In light of the foregoing, Applicant respectfully requests that the Examiner withdraw the rejection of Claim 6 under 35 U.S.C. § 103(a) as being unpatentable over *Smalley* in view of *Kawamura* and further in view of *Satoru*.

4. Rejections Under 35 U.S.C. §103(a) over Smalley in view of Hampden-Smith

The Examiner has rejected Claims 7-11 under 35 U.S.C. § 103(a) as being unpatentable under 35 U.S.C. § 103(a) over *Smalley* in view of *Kawamura*, as applied to Claim 1, and further in view of Hampden-Smith et al., U.S. Patent Publication 2003/198849 ("*Hampden-Smith*"). Final Office Action at page 5.

Applicant respectfully traverses the rejection.

Claims 7-11 are dependent upon Claim 1, which has been amended as stated above to claim a fuel cell electrode comprising single-wall carbon nanotubes that are derivatized with a functional group. *Hampden-Smith* teaches an electrocatalyst powder that comprises an active species, such as platinum, on a support phase, such as "primary carbon particles having an average particle size of from about 10 to about 100 nanometers." (Paragraph 0028.) The Examiner contends that *Hampden-Smith* discloses "homo- and hetero-fullerene and carbon nanotube based material," referring to paragraph 109. (Final Office Action at page 5.) Note that Claim 1 has been amended to state that the single-wall carbon nanotubes have a diameter in the range of about 0.7 nm to about 3.5 nm, whereas *Hampden-Smith* discloses larger carbon particles in the range of 10-100 nm. Neither *Kawamura* nor *Hampden-Smith* suggests single-wall carbon nanotubes having the diameter recited in Claim 1, nor do the references suggest single-wall carbon nanotubes derivatized with a functional group.

In light of the foregoing, Applicant respectfully requests that the Examiner withdraw the rejection of Claims 7-11 under 35 U.S.C. § 103(a) as being unpatentable over *Smalley* in view of *Kawamura* and further in view of *Hampden-Smith*.

5. Rejections Under 35 U.S.C. §103(a) over Smalley in view of Hampden-Smith

The Examiner has rejected Claims 13-16 under 35 U.S.C. § 103(a) as being unpatentable over *Smalley* as applied to Claim 1, and further in view of *Hampden-Smith*. Final Office Action at page 6.

Applicant respectfully traverses the rejection.

Claims 13-16 are dependent upon Claim 1, which, as amended, includes, *inter alia*, the element of single-wall carbon nanotubes. As discussed above, neither *Smalley* nor *Hampden-Smith* suggests a fuel cell electrode comprising single-wall carbon nanotubes that are derivatized with a functional group, and that have a diameter of about 0.7 – 3.5 nm.

Therefore, Applicant respectfully requests that the Examiner withdraw the rejection of Claims 13-16 under 35 U.S.C. § 103(a) as being unpatentable over *Smalley* in view of *Hampden-Smith*.

6. Conclusion

As a result of the foregoing, Applicant asserts that the Claims are now in condition for allowance.

The Examiner is invited to contact the undersigned attorney at (713) 934-4094 with any questions, comments or suggestions relating to the referenced patent application.

Respectfully submitted,

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